Technology Development and Transfer Office
John C. Stennis Space Center

Automated Ortho-rectification Software System Enhances Signal and Image Processing

Four-module system vastly improves images processed from SAR data

Perspective views of Othro-Rectified SAR Data

Technology partially developed through a NASA contract has helped a small remote sensing data company improve its prized commercial ground station system and has led to numerous commercial ventures. Through the NASA Small Business Innovative Research (SBIR) Program, Vexcel Corp., a Boulder, CO, company that specializes in remote sensing technologies, including signal and image processing of synthetic aperture radar (SAR) data, has developed technology that has been successfully inserted into its line of SAR processing software. The technology allows users of SAR data to form processed images and other high-level products that are free of distortion due to the imaging geometry or topography changes.

WHAT IS THE TECHNOLOGY?

The NASA SBIR, called "Automated SAR Ortho-rectification Software" produced technology that has been used in four Vexcel COTS SAR software packages: FOCUS, automated SAR image formation software; PHASE, a complete interferometry package; StereoSAR, a stereo processing package; and OrthoSAR, an automated package for SAR terrain and geometry correction and geocoding.

The principle novelty of this software is the inclusion in an integrated and easy-to-use manner, all of the packages required to process the SAR data, extract elevation models and remove the distortions in the imagery that are due to imaging geometry and topography.

HOT Points

- **Integrated four-module software package**
- **Each module fully automated and designed for easy upgrade/adaptation**
- **SAR processing module processes current and future data and uses multi-processor architecture**
- **Interferometry software creates DEMs with vertical accuracy of <1 meter.**
- **SAR stereo software calculates the stereo solution from radar parameters.**
- **Orthorectification software uses radar equations to perform corrections**

The SAR processing software, FOCUS, is fully automated and can be used to process data from all current SAR satellite missions and can easily modified to work with data from future SAR missions. The software is able to take advantage of multi-processor architectures and is significantly faster than previously available systems.

The interferometry software, PHASE, can be used to create digital elevation models with vertical accuracy of several meters (depending on the quality of data). In the displacement map mode, it can also be used to detect movement of the ground due to tectonics or subsidence to a sensitivity of less than a centimeter. While the software allows flexibility in process control, including choice among different algorithms for several of the necessary tasks, it remains easy to use. A particular advantage of the software is that a crude DEM, perhaps one that was created with the stereo processor can be ingested to aid in the production of a more accurate refined DEM.

The SAR stereo software, StereoSAR, is fully automated and uses novel techniques partially developed under the NASA SBIR for the registration and generations of tie points as well as a novel algorithm for calculating the stereo solution from the radar parameters.

The ortho-rectification software, OrthoSAR, is also fully automated and unlike other ortho-rectification packages, it uses the radar equations to perform the correction. The software can optionally produce a map of regions where the imagery is compromised by layover or by shadow.

WHY THE TECHNOLOGY IS IMPORTANT

SAR satellite data is distorted by the imaging geometry of SAR systems and topography, but it contains information that is not obtainable by other imaging techniques. Since SAR is an active coherent imaging technique, accurate DEMs can be obtained using interferometry. These accurate topographic models can be used by OrthoSAR to remove the distortion due to topography and imaging geometry from the imagery.

Before the SBIR, techniques existed for SAR image processing, interferometric processing, stereo processing and ortho-rectification. However, there were no commercial-grade software systems for stereo and ortho-rectification and no integrated system that performed all of these functions.

SUCCESSES

Vexcel has augmented these software modules and incorporated them into its Apex Ground Station environment. Apex was specifically designed for direct reception and processing of data from a variety of remote sensing systems (including NASA's Terra satellite). This inclusion has directly resulted in over $500,000 in sales for Vexcel.

To date, satellite ground stations have appealed to renowned scientific groups, academic institutions and commercial users that are interested in remote sensing data acquisition, not to mention the potential incentives they could reap from direct reception. Despite this appeal, the high cost associated with obtaining and operating a remote sensing ground station makes ownership an implausible option for some national remote sensing centers worldwide.

The Apex Ground Station is an affordable, end-to-end system that comes complete with a tracking antenna that permits coverage within a 2000 kilometer radius of its location, a high speed direct-to-disk data acquisition system that can download information from virtually any satellite, and data processing software for virtually all SAR and optical satellite sensors.

Furthermore, transportable systems, larger and smaller antennas and processing capabilities for a variety of sensors are also available options. Apex Ground Station customers can select processing capabilities for a range of Earth Observation Satellites (EOS), including LANDSAT, MODIS an Quickbird. Vexcel also offers training, installation and ongoing support with the ground station package.

Experienced gained from the complete system has been in part responsible for about $200,000 in royalties from other commercial and software companies. Much of the SAR technology incorporated into the ERDAS radar package is Vexcel technology.

Vexcel has incorporated parts of the complete system into its Center for Southeastern Tropical Remote Sensing (CSTARS), a state of the art remote sensing facility situated at the University of Miami's Rosentail School of Marine and Atmospheric Science.

TARGET MARKETS

Vexcel is using the Apex system that is linked to the Terra satellite to help scientists and NASA personnel measure land and ocean surface temperature, detect fires, monitor ocean color and currents, produce global vegetation maps and data, and assess cloud characteristics and aerosol concentrations.

The systems have been sold to customers worldwide, including the Alaska SAR Facility, a NASA Distributed Active Archive Center that acquires, processes, archives and distributes satellite SAR data for the U.S. Government and research communities.

Vexcel has also found significant interest in this integrated software system among universities and laboratories that wish to use the software to create digital elevation models and to study ground motion/deformation.

FUTURE OF THE TECHNOLOGY

Vexcel has and continues to commit its internal R&D funds to the improvement of this system. The experience and expertise the company has gained from the development of this technology gives Vexcel a unique competitive advantage in the world of SAR data processing.

WHY SBIR?

SBIR is a highly competitive multi-phase program that provides small U.S. businesses with federal funds reserved for conducting serious research and development. Phase I is the start-up segment with awards up to $70,000; if chosen, Phase II awardees are granted up to $600,000 to conduct research and development for two years. The SBIR Program at Stennis Space Center is managed through the Technology Development and Transfer Office. For more information regarding the NASA Small Business Innovation Research Program contact the Technology Development and Transfer Office at Stennis Space Center at (228) 688-1929 or visit http://technology.ssc.nasa.gov.